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(पहला पुनरीक्षण)

Indian Standard

ALUMINIUM AND ITS ALLOYS — TEMPER DESIGNATIONS

(First Revision)

UDC 669·71 : 003·62

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110 002

October 1993 **Price Group 2**

Light Metals and Their Alloys Sectional Committee, MTD 7

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Light Metals and Their Alloys Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This Standard was originally published in 1969. In this revision Tempers have been re-designated in line with Aluminium Association of USA, which are generally followed in all other countries and are similar to alternate designations recommended in ISO 2107 : 1983 'Aluminium, magnesium and their alloys — Temper designations'.

A comparison of new and old temper designations has been given in Annex A for information.

Indian Standard

ALUMINIUM AND ITS ALLOYS — TEMPER DESIGNATIONS

(First Revision)

1 SCOPE

This standard covers temper designations for cast and wrought products of aluminium and its alloys.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
5047 (Part 1) : 1986	Glossary of terms relating to aluminium and aluminium alloys : Part 1 Unwrought and wrought metals (*second revision*)
5047 (Part 2) : 1979	Glossary of terms relating to aluminium and aluminium alloys : Part 2 Plant and operations, thermal treatment, control and testing, finishing

3 TERMINOLOGY

For the purpose of this standard following definitions as given in IS 5047 (Part 1) : 1986 and IS 5047 (Part 2) : 1979 shall apply.

3.1 Annealing

The softening of material by heating to and holding at a temperature sufficient to cause recrystallization.

3.2 Artificial Ageing (Precipitation Treatment)

The controlled heating of solution heat-treated material above room temperature for required duration in order to increase its hardness, proof stress and tensile strength.

3.3 Cast Product (Casting)

Metallic shapes formed by pouring molten metal into a mould.

3.4 Flattening

The flattening of plate or sheet by passing it between a series of staggered rollers of small diameter.

3.5 Natural Ageing (Age Hardening)

The increase in hardness and tensile properties and reduction in ductility which occurs at room temperature after solution treatment and quenching of most heat-treatable alloys. The change in properties is substantially complete within four to five days.

3.6 Partial Annealing (Temper Annealing)

The low temperature treatment of cold-worked material to effect limited softening without causing recrystallization, this treatment is used to obtain certain intermediate tempers.

3.7 Solution Heat-Treatment

Heating at a prescribed temperature followed by rapid cooling (quenching) as a prelude to natural ageing or precipitation treatment (artificial ageing).

3.8 Stabilizing

A low temperature treatment applied to cold-worked aluminium-magnesium alloys to provide mechanical properties which will remain constant.

3.9 Straightening

The removal of longitudinal distortions.

3.10 Strain Hardening

Modification of a metal structure by cold working resulting in an increase in strength and hardness with corresponding reduction in ductility.

3.11 Stretching

The levelling of rolled materials or the straightening of extruded or drawn materials by imparting the minimum permanent extension required to remove distortion.

3.12 Wrought Product

A product which has been subjected to mechanical working by such processes as rolling, extrusion, forging, etc.

4 BASIS OF CODIFICATION

4.1 The temper designations are based on the sequence of basic treatments used to produce the tempers.

4.2 The temper designations, which are used for all cast and wrought products except ingots, follow the designation of aluminium and its alloys and is separated from them by a dash.

4.3 Basic temper designations consist of letters. If sub-divisions of basic tempers are required, they are indicated by a digit, following the letter of the basic temper. Only those treatments or operations which significantly influence the product characteristics are recognized.

5 BASIC TEMPER DESIGNATIONS

5.1 —M as Manufactured

This designation applies to the product which acquired some temper from hot shaping processes for which mechanical property limits apply. This temper designation is applicable for cast products only.

5.2 —F as Fabricated

This designation applies to the products of shaping processes without special control thermal condition or strain hardening and for which no mechanical property limits apply. This temper designation is applicable for wrought products only.

5.3 —O Annealed

This designation applies to wrought products which are fully annealed to obtain the lowest strength condition and to cast products which are annealed to improve ductility and dimensional stability.

5.4 —H Strain Hardened (Wrought Products Only)

This designation applies to products which are subjected to the application of cold work after annealing (or hot forming) or to a combination of cold work and partial annealing or stabilizing treatment in order to secure the specified mechanical properties. The letter **H** is always followed by one or more digits according to basic operation and the final degree of strain hardening.

5.5 —T Thermally Treated to Produce Tempers other than M, F, O or H

This designation applies to products which have their strength increased by thermal treatment, with or without supplementary strain hardening. The letter **T** is always followed by one or more digits indicating the specific sequence of treatments.

6 SUBDIVISIONS OF BASIC TEMPER DESIGNATIONS

6.1 —H Strain Hardened

6.1.1 For wrought products of aluminium and its alloys sub-divisions of temper **H** are made according to the basic operations described in **5.4** and the final degree of strain hardening as follows:

a) The combination of basic operations is indicated by the first digit of the designations as below. The designations **H1, H2, H3** are always followed by second digit as given in (b).

H1 Strain-Hardened Only

Appplies to products which are strain-hardened to obtain the desired strength without supplementary thermal treatment. The digit following designation indicate degree of hardening.

H2 Strain-Hardened and Partially Annealed

Applies to products which are strain-hardened more than the desired final amount and then reduced in strength to the desired level by partial annealing. For alloys that age-soften at room temperature, the **H2** tempers have the minimum tensile strengths as the corresponding **H3** tempers. For other alloys, the **H2** tempers have the same minimum tensile strength as the corresponding **H1** temper and slightly higher elongation. The digit following this designation indicates the degree of strain hardening remaining after the product has been partially annealed.

H3 Strain-Hardened and Stabilized

Applies to products which are strain-hardened and whose mechanical properties are stabilized by a low temperature thermal treatment which results in slightly lower tensile strength and improved ductility. This designation is applicable to only those alloys which, unless stabilized, gradually age-soften at room temperature. The digit following this designation indicates the degree of strain hardening remaining after the stabilization treatment.

NOTE — This temper designation generally applies to aluminium-magnesium alloys.

b) The final degree of strain hardening is indicated by the second digit preceded by **H1** or **H2** or **H3**. The following designations indicate the condition of the alloy [the letter **X** denotes the first digit as given in (a) above].

H X 8 Full hard temper indicates having an ultimate tensile strength equivalent to that achieved by a cold reduction of approximately 75 percent from **0** temper.

H X 4 Tensile strength approximately midway between that of the **0** temper and that of the **H X 8** temper.

H X 2 Tensile strength approximately midway between that of the **0** temper and that of the **H X 4** temper.

H X 6 Tensile strength approximately midway between that of the **H X 4** temper and that of the **H X 8** temper.

6.2 —T Thermally Treated

6.2.0 Numerals 1 through 10 following the **T** indicate specific sequences of basic treatments as follows (*see* Note 1).

6.2.1 T1 — *Cooled from an Elevated Temperature Shaping Process and Naturally Aged to a Substantially Stable Condition*

Applies to products which are not cold worked after cooling from an elevated temperature shaping process or in which the effect of cold work in flattening or straightening may not be recognized in mechanical property limits.

6.2.2 T2 — *Cooled from an Elevated Temperature Shaping Process, Cold Worked and Naturally Aged to a Substantially Stable Condition*

Applies to products which are cold worked to improve strength after cooling from an elevated temperature shaping process or in which the effect of cold work in flattening or straightening is recognized in mechanical property limits.

6.2.3 T3 — *Solution Heat-Treated* (*see* Note 2), *Cold Worked and Naturally Aged to Substantially Stable Condition*

Applies to products which are cold worked to improve strength after solution heat-treatment or in which the effect of cold work in flattening or straightening is recognized in mechanical property limits.

6.2.4 T4 — *Solution Heat-Treated* (*see* Note 2) *and Naturally Aged to Substantially Stable Condition*

Applies to products which are not cold worked after solution heat-treatment or in which the effect of cold work in flattening or straightening may not be recognized in mechanical property limits.

6.2.5 T5 — *Cooled from an Elevated Temperature Shaping Process and then Artificially Aged*

Applies to products which are not cold worked after cooling from an elevated temperature shaping process or in which the effect of cold work in flattening or straightening is not recognized in mechanical property limits.

6.2.6. T6 — *Solution Heat-Treated* (*see* Note 2) *and then Artificially Aged*

Applies to products which are not cold worked after solution heat-treatment or in which the effect of cold work in flattening or straightening is not recognized in mechanical property limits.

6.2.7 T7 — *Solution Heat-Treated* (*see* Note 2) *and Stabilized*

Applies to wrought products which are artificially aged after solution heat-treatment to carry them beyond a point of maximum strength to provide control of some significant characteristics. Also applies to cast products that are artificially aged after solution heat-treatment to provide dimensional and strength stabili y.

6.2.8 T8 — *Solution Heat-Treated* (*see* Note 2) *Cold Worked and then Artificially Aged*

Applies to products which are cold worked to improve strength after solution heat-treatment or in which the effect of cold work in flattening or straightening is recognized in mechanical property limits.

6.2.9 T9 — *Solution Heat-Treated* (*see* Note 2) *Artificially Aged and then Cold Worked*

Applies to products which are cold worked to improve strength after solution heat-treatment and artificial ageing

6.2.10 T10 — *Cooled from an Elevated Temperature Shaping Process, Cold Worked and Artificially Aged*

Applies to products which are cold worked to improve strength after cooling from an elevated temperature shaping process or in which the effect of cold work in flattening or straightening is recognized in mechanical property limits.

6.3 If necessary any additional digits the first, of which shall not be zero, may be added to indicate any variation of sub-division of basic tempers.

NOTES

1 A period of natural ageing at room temperature may occur between or after the operations listed for the **T** tempers. Control of this period is exercised when it is metallurgically important.

2 Solution heat-treatment is achieved by heating cast or wrought products to a suitable temperature and holding at that temperature long enough to allow constituents to enter in to a solid solution and cooling rapidly enough to hold the constituents in the solid solution. Some **6000** series alloys attain the same specified mechanical properties whether furnace solution heat-treated or cooled from an elevated temperature shaping process at a rate rapid enough to hold constituents in solution. In such cases the temper designations **T3, T4 T6, T7, T8** and **T9** are used to apply to either process and are appropriate designations.

ANNEX A

(*Foreword*)

COMPARISON OF IS TEMPERS WITH ISO TEMPERS

Old IS tempers	New IS tempers	ISO tempers
—	M	M
M	F	F
0	0	0
H	H	H
H1	H X 2	H X B
H2	H X 4	H X D
H3	H X 6	H X F
H4	H X 8	H X H
—	T1	TA
—	T2	TC
WD	T3	TD
W	T4	TB
P	T5	TE
WP	T6	TF
WS	T7	TM
WDP	T8	TH
WPD	T9	TL
—	T10	TG
PD	—	—
WR	—	—

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